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NMA MS1-1980
Practice for Operational Practices/Inspection and Quality Control for Alphanumeric Computer Output Microfilm

8719 Colesville Road
Silver Spring, Maryland 20910
301/587-8202

NMA

The Image Processing Association

This standard has been adopted for Federal Government use. Details concerning its use within the Federal Government are contained in FIPS PUB 82, Guideline for Inspection and Quality Control for Alphanumeric Computer Output Microforms. For a complete list of the publications available in the Federal Information Processing Standards Series, write to the Office of Standards Administration, Institute for Computer Sciences and Technology, National Bureau of Standards, Washington, DC 20234.

Standard Practice for Operational Practices/Inspection and Quality Control for Alphanumeric Computer-Output Microforms

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Contents

Foreword

[This foreword is not a part of National Micrographics Association Standard *Practice for Operational Practices/Inspection and Quality Control for Alphanumeric Computer-Output Microforms*, NMA MS1–1980.]

This standard represents a major revision of MS1–1971, *Quality Standards for Computer-Output Microfilm*. As the use of computer-output microfilm (COM) continues to grow and as its applications become more sophisticated, the need for expanded, up-to-date, useful methods for prescribing film and image quality for achieving consistent, acceptable results has become obvious.

Since MS1–1971 was published, the need to separate the requirements of COM recorders functioning principally as computer line printer equivalents (alphanumeric) from graphic COM recorders (such as those used in generating engineering drawings and graphic arts output) has become apparent. Although both types of recorders have certain characteristics in common, graphic recorders must accurately produce geometric shapes, graphs and three-dimensional views along with dimensions and multiple size characters. The principal concerns with alphanumeric recorders, however, are legibility and the reproduction characteristics of printed text.

After evaluating user requirements, the COM Quality Standards Committee concluded that a quality standard for alphanumeric COM was not feasible and that a standard practice would more fully satisfy user needs. This standard therefore addresses equipment, supplies and operational procedures related to alphanumeric COM used for business and government records. Included are recommendations related to legibility, first-generation camera films and subsequent-generation duplicating films, film processing, form-slide quality (including original artwork), image density, film stability and film storage. A test method for use in maintaining consistent image quality is included to replace the random character blocks specified in MS1–1971.

This standard is not intended to be an all-inclusive quality-control document. Its purpose is to supply information useful in maintaining the quality of alphanumeric COM. For general quality-control information, the user should refer to MS23–1979.

This standard is confined to effective reductions up to and including 48X. Since reductions greater than 48X have not been standardized at this time, this standard does not address quality considerations for such image sizes.

Of singular importance in alphanumeric COM filming is the legibility of the information supplied to users. Obviously, if the information is not legible, it has no value. So, in a sense, it is of primary importance to establish guidelines for legibility, with less emphasis on other characteristics. Since considering all possible systems and configurations is virtually impossible, this standard attempts to create guidelines that can significantly increase the probability of acceptable results.

In microfilming hardcopy documents, planetary and rotary camera test targets are used to monitor resolution and density. Resolution targets on COM form slides are used to establish optimum focus, but they do not provide a measure of character resolution or legibility obtained from the image generator. Although character quality from the image generator cannot be measured using resolution targets, it can be compared to an image of a reference form slide in the same frame to establish a relative quality level. The method of establishing quality limits for COM images using characters printed randomly in blocks as specified in MS1–1971 has been tried with minimal success. Evaluating alternative methods for using the form slide as the reference led to the inclusion of sans serif *E* and *H* characters on the Alphanumeric COM Quality Test Slide. The Committee selected these letters because they contain both vertical and horizontal lines common to most character fonts, regardless of the method of character generation. Although differences concerning aspect ratio (character height to width ratio) and the location of central horizontal lines occur in various recorders, the Committee believes that the similarities are adequate for benchmark comparisons. The letters *E* and *H* represent simple shapes that are very easy to compare; however, the more complex and similar symbols such as %, @, *B* and 8, *S* and 5, *Z* and 7 and *M* and *W* should also be examined.

Proper COM system performance requires controlling both character and background densities to insure good duplication of the camera film. Values covering line and background densities and uniformity are presented in this standard.

The recommended Test Form Slide outlined in this standard contains density squares large enough to allow COM operators to measure density on the film with an ordinary densitometer. Although measuring the large area density does not determine character line density, it is very useful in maintaining consistent exposure on the form slide. The form-slide exposure can then be compared to maintain proper exposure of characters from the image generator.

Guidelines for preparing form slides are also presented in this standard. The primary dimensions used in this standard are in the metric system, with all dimensions given in millimeters. The English equivalents are given parenthetically.

Any suggestions for improving this standard should be sent to the Technical Director, National Micrographics Association, 8719 Colesville Road, Silver Spring, MD 20910.

This standard was developed under the auspices of the NMA Standards Board which approved it as a National Micrographics Association Standard in January 1980. The Standards Board had the following members at the time it processed and approved this standard.

Robert A. Glotfelty, *Chairman*
Samuel M. Trippe
Marilyn E. Courtot
Charles S. Heinmiller
Jeffrey W. Heynen
Paul F. Vaiana
Henry C. Frey

The National Micrographics Association COM Quality Standards Committee had the following members at the time it processed and approved this standard.

Sherman H. Boyd, *Chairman*

ORGANIZATION	REPRESENTATIVE
Bell & Howell Company	John Scarborough
Bell System Laboratories	A. F. Pavlick
	Henry C. Frey, *Alternate*
	D. L. Shee, *Alternate*

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NCR Corporation	Tom Lyman
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Photographic Sciences Corporation	Dave Horsey
U.S. Department of Energy	Robert W. Ludka
Xidex Corporation	John T. Blakney

Practice for Operational Practices/Inspection and Quality Control for Alphanumeric Computer-Output Microforms

1. SCOPE

This standard describes operational and quality-control guidelines for alphanumeric computer-output microfilm (COM) recorders and microforms. It is limited to images of line printer equivalent output only, such as those used for business and government records.

This document covers microforms containing data generated by dynamic energy sources, such as cathode-ray tubes, light-emitting diodes or lasers, and fixed data, such as that contained on a form slide, with effective reductions up to and including 48X. The subjects covered include a method for comparing legibility of the dynamic information to that contained in an image of the Alphanumeric COM Quality Test Form Slide when exposed in the same frame and duplicated onto silver, diazo and vesicular films. The films, film processing, film storage, film density practices and guidelines for preparing form-slide artwork and form slides are also discussed.

2. DEFINITIONS

The following definitions apply to terms used in this standard. Other terms shall be defined as stated in the *National Micrographics Association Glossary of Micrographics*, NMA TR2–1980.

archival film—a photographic film that is suitable for the preservation of records having permanent value when properly processed and stored under suitable storage conditions, provided that the original images are of suitable quality.

line density—the density of the lines, letters or other nonbackground information in an image.

silver-gelatin film—wet-processed, silver-halide film with silver as the image-forming material and with a gelatin binder (matrix).

thermally processed silver film—heat-developed, light-sensitive film with silver as the image-forming material.

3. MICROFILM TYPES

The most commonly used first-generation microfilms are silver-gelatin film and thermally processed silver film. Duplicating films are diazo, vesicular and silver gelatin. See Figure 1 for COM-generation terminology.

Microfilm generally consists of a photosensitive emulsion coated onto a flexible base material, which may be either acetate or polyester. The base may range in thickness from 0.06 to 0.18 mm (0.0024 to 0.0070 inch). The thinner base (0.06 mm) is used primarily in roll-film systems (including cassettes and cartridges), while the thicker base (0.18 mm) is used for sheet film (microfiche).

3.1 SILVER-GELATIN FILM. Silver-gelatin film, which is similar in many respects to black-and-white film used in pictorial photography, is characterized by high light sensitivity and the use of wet processing. Depending on the processing method, silver-gelatin film may yield either a positive- (1P) or negative-appearing (1N) image. Direct-image COM film produces a negative-appearing (1N) image with conventional processing.

Silver-gelatin film has sufficient resolution to yield high-quality images up to and including 48X effective reductions. Density and contrast of properly exposed and processed silver-gelatin film are also adequate for high-quality duplication. Silver-gelatin print and duplicating films may also be used to make duplicate microforms.

3.2 THERMALLY PROCESSED SILVER FILM. Thermally processed silver film is less sensitive to light than the silver-gelatin film normally used in COM recording, but it shows significantly greater light sensitivity than diazo or vesicular films. After exposure, the film is developed at an elevated temperature for a few seconds. Thermally processed COM silver films produce positive-appearing (1P) images with sufficient resolution and contrast to yield high-quality images at reductions up to 48X and are adequate for high-quality duplication.

3.3 DIAZO FILM. Diazo microfilm is used for making duplicate microforms. The film is exposed by contact printing, using high-intensity ultraviolet radiation such as that obtained with a mercury, metal halide mercury or xenon flash lamp. Because of its low sensitivity to visible light, diazo film may be handled in normal room light for short periods (such as when loading it into a duplicator) without affecting the image properties.

Diazo films are direct-image duplicating films and maintain polarity: A negative-appearing master (1N) produces a negative-appearing diazo duplicate (2N). Development occurs by passing the film through a heated chamber containing aqueous ammonia or by subjecting it to anhydrous ammonia under pressure to form azo dye, although some diazo films can be developed by heat alone.

Blue, blue–black and black high-contrast diazo films are commonly used for COM duplication. Although film choice is a matter of user preference, users should first examine the film in a reader, since the reader and film combination can affect the quality of the image displayed. Diazo film maintains very high resolution,

medium or high contrast and can yield excellent images at effective reductions up to and including 48X.

3.4 VESICULAR FILM. Vesicular microfilm, like diazo, is used for making duplicate microforms. It, too, is exposed by contact printing, using high-intensity ultraviolet light. However, its sensitivity to ultraviolet light is greater than that of diazo film. Its low sensitivity to visible light allows it to be handled in normal room light for short periods (such as when loading it into a duplicator) without affecting the image properties.

Most vesicular films change image polarity; i.e., a positive-appearing master (1P) produces a negative-appearing duplicate (2N). Vesicular film is developed by heat. It is available in a variety of visual background colors but generally appears neutral on a reader screen.

Vesicular film density is achieved primarily by scattering light rather than by absorption; therefore, projection viewing in a reader is more important than diffuse viewing. The projection density (See Section 8) attainable using vesicular film is usually equal to or greater than that of diazo film. Although vesicular film has a lower limiting resolution than diazo film, the film has higher contrast and can yield very good images at effective reductions up to and including 48X. Some combinations of vesicular film and microfilm readers may affect the quality of the image displayed to the users.

4. FILM PROCESSING

Camera film processing is one of the most important steps in producing consistent, high-quality microfilm. As much care must be taken in film processing as was taken in recording the data with the COM recorder.

4.1 SILVER-GELATIN FILM PROCESSORS. A silver-gelatin film processor is a mechanical device that transports the film through a series of chemical baths, washing and drying stages to produce the final photographic image. To achieve high quality, it is necessary to consider the following items: (1) repeatable density from roll to roll and from day to day; (2) uniform density (minimal streaks or mottle); (3) complete edge-to-edge processing; (4) thorough washing if archival permanence is required; (5) proper drying, neither under- nor overdrying nor the presence of water droplets; and (6) freedom from scratches, dust, chemical residue, water spots and physical deformation.

4.1.1 OFF-LINE FILM PROCESSORS. Off-line automatic film processors are not connected directly to the COM recorder. In these units, film processing represents a separate operation. The film processor transports the film through tanks of active processing chemicals and wash water. The sequence of steps depends on the type of processing and on the processor configuration. After processing, the film is dried automatically and

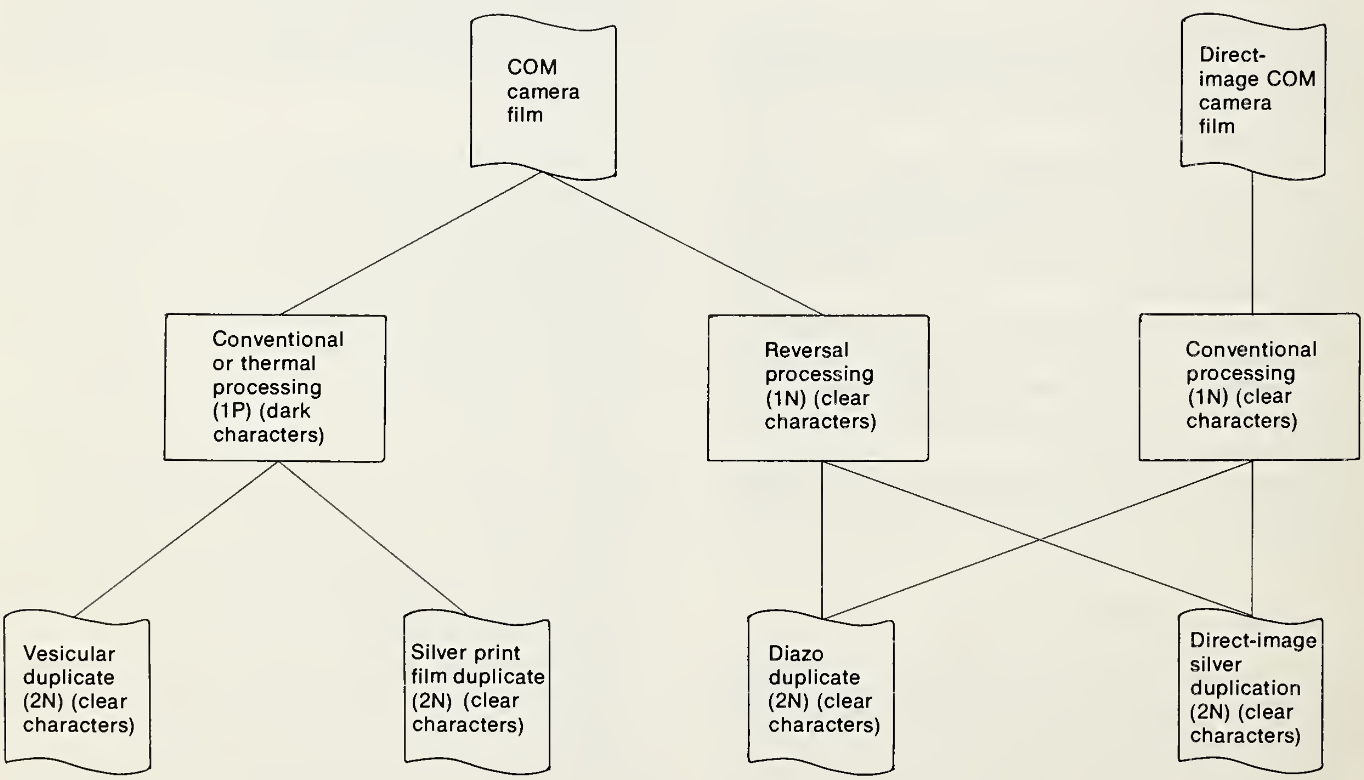

FIGURE 1. COM-generation terminology.

wound onto a take-up mechanism. These processors may use either a plastic leader to thread or pull the film through the processor or a self-threading transport. Automatic processors usually provide transport speed (time) control of the film through the solutions and temperature control of the solutions and drying chambers. Proper chemical activity can be maintained by replenishing or replacing chemicals after a specified time or after a specified volume of film has been processed.

4.1.2 IN-LINE FILM PROCESSORS. An in-line film processor is directly connected to the COM recorder and is generally an integral part of the equipment. Present in-line processors are used to process cut microfiche. Like off-line processors, in-line processors transport the film through a series of active processing chemicals and wash water. After processing, the film is dried automatically and ready for use when it leaves the system. This type of processor usually is operated at a fixed speed and temperature and does not replenish chemicals to maintain proper chemical activity. Rather, chemicals are changed after a fixed number of microfiche have been processed or after a fixed number of operating hours.

4.2 PROCESS CONTROL

4.2.1 OFF-LINE PROCESSORS. Controlling film processing through process-control procedures is one of the most important aspects in maintaining constant uniformity of COM output. Processors must be monitored on a regular basis to insure consistent quality. Process-control strips (sometimes called sensitometric strips) should be used frequently; at a minimum, they should be used at the start of processing each day, after changing chemicals or whenever the output film fails to meet the established quality level. Lack of proper process-control procedures is one, if not the major, factor in poor quality output.

Process-control strips should be the same type of emulsion as the microfilm being used, and it is preferable for users to produce their own process-control strips at the time of use. If a sensitometer for exposing control strips is not available, preexposed control strips usually can be obtained from the film supplier.

Process-control strips consist of successive steps of differing exposures that become steps of differing density after processing. After processing, the density of the steps on the control strip is measured using a densitometer. When conventional processing is used, two steps usually are monitored: one at the minimum density and one at the density step recommended for the particular application.

In addition to measuring various density values, proper quality control requires maintaining a film processor control log. An example of such a control log is shown in Figure 2. In using the log, it is necessary to establish control limits, that is, a range of density values representing acceptable limits for a particular situation. Limits, rather than precise values, are needed because of the normal variations encountered in practice. The particular example shown uses conventional processing (producing a positive-appearing image). The control regions represent the base-plus-fog level and a density of 1.0 (which approximates character density). In reversal processing, different values would be chosen: maximum density, 1.8 or greater, and minimum density, a density approximately 0.2 above the base-plus-fog level. The steps on the control strips that come closest to the desired density levels should be selected as references, since it is doubtful whether the exact densities desired would be present on the control strips.

To establish process-control limits, it may be possible to obtain information from the film manufacturer. However, it is generally necessary to establish these values experimentally. One method that may be used is to process at least 20 control strips over a short period of time, a day or two at the most. All control strips for this test should come from the same roll of film or have the same batch number. The density of the steps on the control strips chosen for use in control should be measured and recorded.

Once the data is obtained, it can be used to establish an average, or aim, value for each of the steps. It also may be used to establish limits. To do this, the limits for each control level should be set plus or minus 2 *sigma* ($2\ \sigma$) of the mean.

The *sigma* values are obtained as follows. First, determine the average density at each of the control steps. This measure represents the aim value. Next, subtract each value obtained at a given control level from the average density. Square each of the plus or minus values (this procedure will yield a series of positive numbers), add the series, then divide the result by the number of samples. Next, find the square root of the value obtained. This figure represents *sigma* for the sample, often called the standard deviation. Twice this value should be added to and subtracted from the aim value, thereby establishing control limits. It is not necessary to establish a lower limit for minimum density or an upper limit for maximum density of the control strips.

Whenever a new roll of film is used for making process-control strips, a crossover should be established by processing in the same run three or four control strips made on the new roll of film and three or four made from the old roll. The density of the control steps from both strips should be measured and averaged, and the *difference* in the average density of the various control steps of the two sets should be determined. Using this difference, new aim points and control limits should be raised or lowered by the difference in the densities measured. For instance, if the density on the old strip had an aim of 1.00 (Figure 2) and in this test the average measured 1.04 and the new strips measured an average of 1.09, then the new aim

and control points would be increased by 0.05 to yield a lower limit of 0.99, an aim point of 1.05 and an upper limit of 1.11.

In routine use control strips should be processed one or more times a day or whenever a processor problem is suspected. If the first control strip shows any points outside the established limits, a second strip should be processed to ascertain whether it is a processor problem or an aberration. If the second control strip is also outside the control limits, the cause should be determined. The problem may be due to improper development time or temperature or to a change in the processing chemicals. If the development time and temperature are set properly, then the processing chemical activity probably has changed. In this case, the chemicals, usually the developer, should be replaced.

4.2.2 IN-LINE PROCESSORS. With in-line processors, using standard process-control strips usually is not possible. Also, since these processors operate at fixed speeds and temperatures and since the processing chemistry is premixed, using standard control strips serves no practical purpose.

The Alphanumeric COM Quality Test Form Slide described in section 6 may be used as an alternative method to monitor processor operation. Using this form slide assumes that the light output from the forms flash does not change noticeably between chemical changes.

The method for using the form slide is similar to that for using process-control strips, except that different density values may be involved. First, the form slide should be exposed at the regular form-slide setting used in normal production. At least four or five frames should be exposed in order to obtain an average exposure, since minor exposure variations may occur from frame to frame. After exposure and processing, the three densities obtained from exposing the two density test areas and the background density (which may be measured using an unexposed portion of the film) should be measured.

Maintaining a film process-control log is as important with in-line processing as with off-line. The test should be made when changing chemistry and periodically throughout the chemical life. In contrast to off-line processing, different control limits usually are required. For instance, with conventional processing the minimum density generally remains rather constant, while the middle and upper densities gradually decrease. In this case, the lower control limits are more important than the upper limits. The lower control limits may be established experimentally by running the test *just before the recommended chemical change;* that is, when satisfactory COM output is marginal.

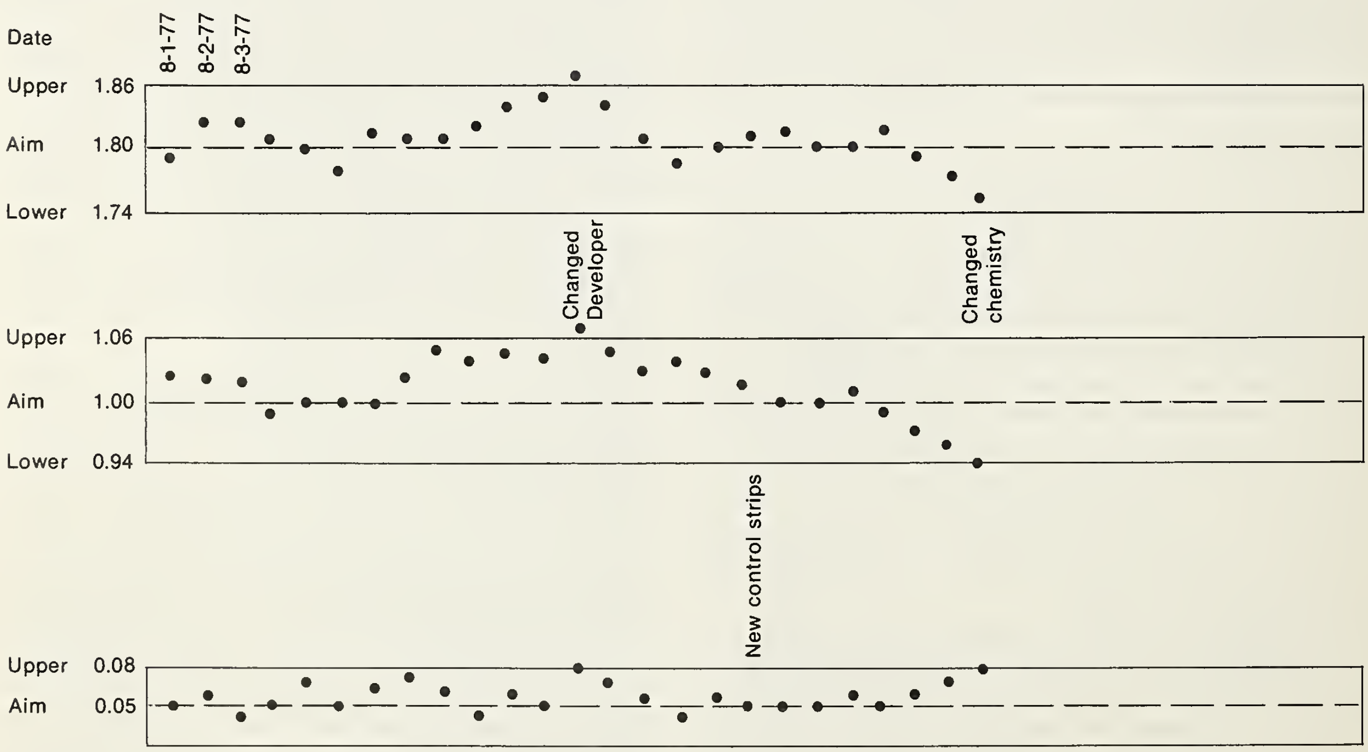

FIGURE 2. Film processor control log.

In reversal processing the most important density will be the middle value. The minimum density may not change noticeably because of the relatively large area of the density square, and the background density generally will increase. Once again, the control limits may be established experimentally by running the test *immediately before the recommended chemical change.*

4.3 SILVER-GELATIN FILM PROCESSING. The film supplier's recommendations should be followed for film processing. Although special circumstances may require departing from the recommended conditions, in general it will not be possible to maintain proper process control if the process conditions depart significantly from those recommended.

When practical, adding a silver recovery unit to the processor is recommended, especially when conventional processing yielding a positive-appearing (1P) image is used. A silver recovery unit may be useful for two reasons: First, if a large quantity of film is processed, recovering silver from the fixing bath can yield a source of income that may more than pay for the cost of the silver recovery unit and for the labor to operate it over a period of time. Second, with the increased environmental restrictions regarding disposal of photographic chemicals, particularly such substances as silver, it may be required to reduce the silver concentration to an acceptable level before discharging the effluent into a sanitary sewer.

4.3.1 CHEMICALS. The chemicals used in the system must be compatible with the film and the processor. The chemical supplier's recommendations on the correct use of chemicals should be followed. The user should consider the advantages of premixed chemicals and chemical concentrates. The recommended replenishment rates and frequency of chemical change should be followed. Using process-control strips will assist in monitoring these requirements.

4.3.2 WASHING. The processor should provide adequate washing and temperature control for the intended use of the film. The temperature of the wash water should not differ significantly from the other process solutions. Users should check the quality of water in their locality. Very hard water may need to be treated before being used, while excessively soft water may lead to abrasion and/or reticulation. The practical limits on water hardness are 16 to 150 milligrams per liter (parts per million) (0.9 to 8.8 grains per U.S. gallon) when measured as calcium carbonate. Most large city water supplies necessitate using filters to keep dirt out of the photographic processor. If you are producing archival microfilm or microfilm for medium- or long-term retention, it may be necessary to use a flow regulator, or a flow meter, with pressure-balancing valves to monitor the rate at which water enters the processor. The ideal pH range for wash water is 7.0 to 8.5.

4.3.3. DRYING. Film and processor suppliers' recommendations for drying film should be followed. The following precautions apply primarily to large processors. The user may want to install air filters to insure that the air used is free of dust and dirt particles. Although adequate drying is essential to prevent film from sticking together, care should be taken to prevent overdrying or the film may become brittle or exhibit excessive curl. Drying time depends on relative humidity, temperature of the drying air, moisture content of the film and film type. For polyester-based films, set the dryer slightly above the temperature at which the films nominally emerge. For acetate-based films, this temperature is hotter than required, but still adequate. Drying cabinets should be grounded to prevent the buildup of static electricity.

4.4 CONVENTIONAL FILM PROCESSING. Conventional processing of silver-gelatin film requires a chemical bath to develop the latent image formed during exposure; a second bath to dissolve, or fix, the unexposed silver-halide grains; a wash step to remove residual chemicals; and, finally, a drying step. The development stage is the most critical step in this process. To achieve consistent results, development time, agitation, temperature and the chemical activity of the developer bath must be controlled closely. Chemical activity frequently is maintained by using a replenishment system that adds fresh chemicals while the film is being processed. In some systems, chemicals are replaced periodically rather than replenished. In these systems the chemicals usually are changed after a fixed period of time or after a prescribed quantity of film has been processed. Variations in development time, temperature, chemical activity and agitation will influence the characteristics of the developed film. Conventional processing usually produces a positive-appearing (1P) COM image.

4.5 REVERSAL PROCESSING. In full-reversal processing, the film is first developed to produce a positive-appearing (1P) silver image (the same first step as in conventional processing). The film next passes through a bleach bath that removes the developed silver image, leaving clear image areas. The remaining silver halide, which is still light sensitive, is reexposed and redeveloped to produce a dark background and a negative-appearing (1N) image. Finally, the film is fixed to remove any remaining silver halide. Reversal processing is commonly used when diazo film is used for duplication.

In some processors the redevelopment and fixing steps are eliminated to produce partial-, or halide-, reversal processing. Until small, full-reversal processors were readily available, this method was used when the duplicate film was diazo.

This halide-reversal process has some disadvantages. The silver-halide background changes tone in a reader, and a more specular light source is required for duplication

and reading. Partially because of these disadvantages, the halide-reversal process has declined in use.

5. PERMANENCE OF MICROFORMS

Computer-output microfilm has a useful life, depending on the following classifications of film stability. The classifications apply only to storage copies of film. Storage copies should never be used as work copies when frequent use may subject them to abrasion, dirt, physical damage or environmental changes, making them unfit for preservation. When there is a need for more than very occasional reference to an archival record film copy, a duplicate work copy should be printed.

5.1 ARCHIVAL MICROFORMS: RECORDS FOR PERMANENT STORAGE. Archival is considered forever or permanent. At present, only wet-processed, silver-gelatin films may be considered archival. In order to be classified as archival microfilm, the silver-gelatin film must meet the requirements of ANSI PH1.28, *Specifications for Photographic Film for Archival Records, Silver-Gelatin Type, on Cellulose Ester Base,* or PH1.41, *Specifications for Photographic Film for Archival Records, Silver-Gelatin Type, on Polyester Base,* and it must be processed and stored properly under the archival conditions specified in ANSI PH1.43, *Practice for Storage of Processed Safety Photographic Film.* After film processing, the residual thiosulfate ion must not exceed 0.7 micrograms per square centimeter but should be greater than zero. The level of residual thiosulfate may be determined by following the methylene-blue method described in ANSI PH4.8, *Methylene Blue Method for Measuring Thiosulfate and the Silver Densitometric Method for Measuring Chemicals in Films, Plates and Papers.*

In full-reversal processing, the film must pass through a fixing bath after passing through the redeveloper and be washed satisfactorily to be considered archival. Testing for residual thiosulfate ion must be conducted using a clear area of the film within 2 weeks of processing. Full-reversal processing that does not use a separate fixing stage and halide-reversal film that does not undergo a fixing stage do not satisfy archival processing requirements.

5.2 LONG-TERM MICROFORMS. Long-term film has a useful life of at least 100 years. This classification may include some diazo films that satisfy the requirements of "American National Standard Specifications for Stability of Ammonia-Processed Diazo Photographic Film, ANSI PH1.60-1979."

5.3 MEDIUM-TERM MICROFORMS. Medium-term film has a useful life of at least 10 years. In most COM applications the camera microfilm will need a maximum useful life of 10 years and will not be retained as an archival record. Some diazo films that satisfy the requirements of PH1.60 will be considered medium-term films.

5.4 DIAZO DUPLICATING FILMS. Some diazo films will satisfy the requirements of ANSI PH1.60. Diazo films that do not satisfy the requirements of PH1.60 for long-term film may meet the requirements for medium-term films.

5.5 THERMALLY PROCESSED SILVER AND VESICULAR MICROFILMS. At present no definitive statement can be made concerning the keeping qualities of thermally processed silver and vesicular microfilms, since no standards have been established for measuring these qualities. A task group within Subcommittee PH1.3 of the American National Standards Institute currently is working on a standard related to vesicular films, but the work is incomplete. Studies also have been conducted regarding the stability of these films.[1] According to J. B. Rhoads, former archivist of the United States, "Permanent or archival record film can be defined as any film that is equal to or better than silver film, as specified in ANSI specifications PH1.28 and PH1.41. We realize that equating other film types to silver may not be the best criteria, but at this time it is the only standard we have. Silver has been around long enough to lend some credence to its stability as an archival material; yet, if newer materials can be qualified, they, too, should be considered for certification."[2]

6. ALPHANUMERIC COM QUALITY TEST FORM SLIDE

The Alphanumeric COM Quality Test Form Slide described in this section and illustrated in Figure 3 was designed to assist users in establishing and maintaining the quality of the output from the COM recorder. To use this form slide properly, the film processor must be operating properly and yield process-control strips with densities within established limits.

Evaluating COM image quality is not as easy as evaluating output image quality from source-document cameras, principally because alphanumeric-only COM recorders cannot generate patterns equivalent to the NBS Microcopy Resolution Test Chart. Although it does not provide quantitative values of quality, using the COM Quality Test Form Slide permits establishing and maintaining the quality level required for the particular application. The resolution test target located on the form slide indicates the quality of the form-slide

1. Kenneth R. Kurtilla, "Dry Silver Film Stability," *Journal of Micrographics* 10 (1977): 113–117; and Tulsi A. Ram and Edwin W. Potter, Stability of Vesicular Microfilm Images II, *Photographic Science and Engineering* 14 (1970): 283–288.

2. James B. Rhoads, "Dialog on Standards: Archival Permanence" (correspondence), *Journal of Micrographics* 9 (1976): 193–194.

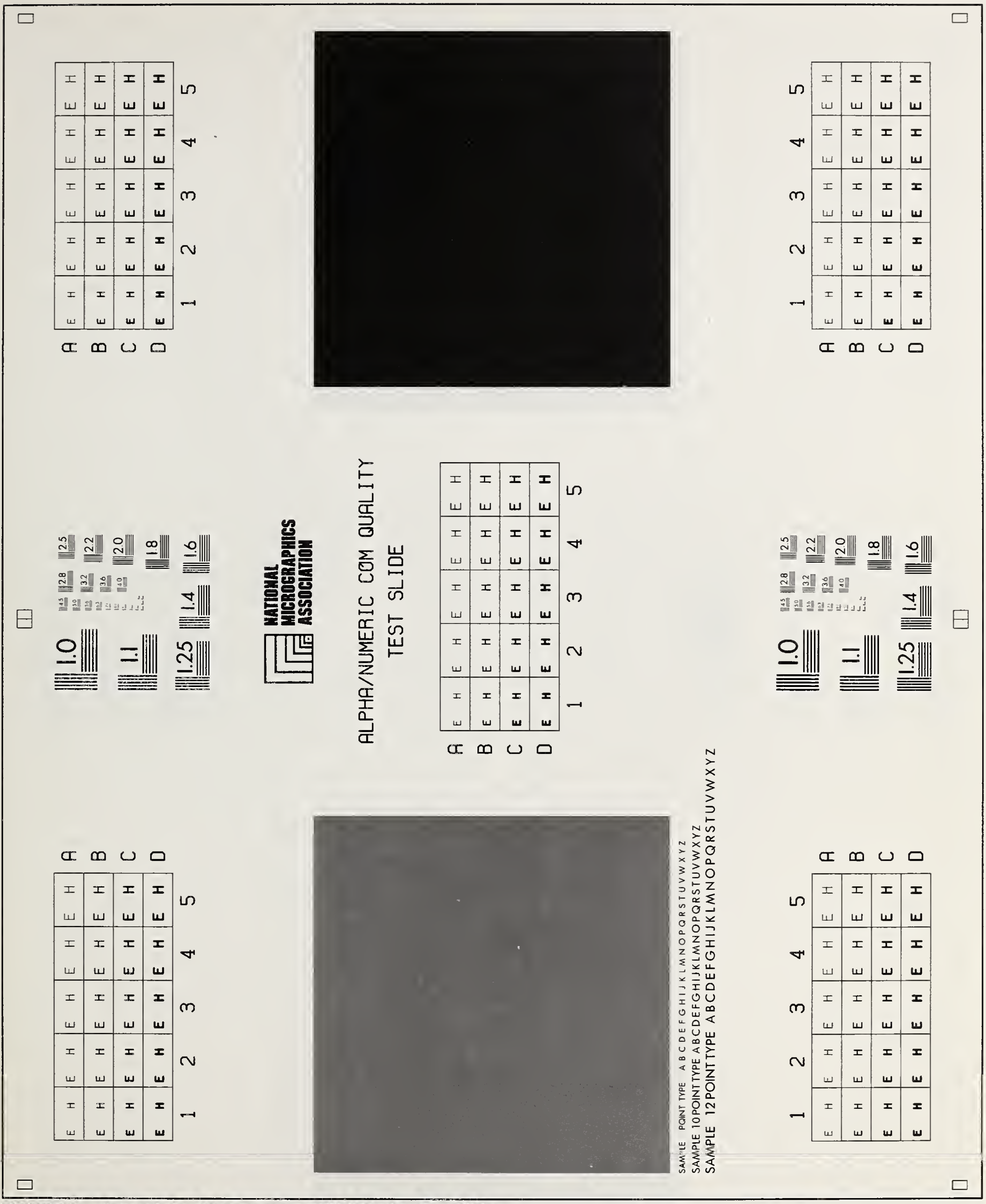

FIGURE 3. Artwork for Alphanumeric COM Quality Test Slide.

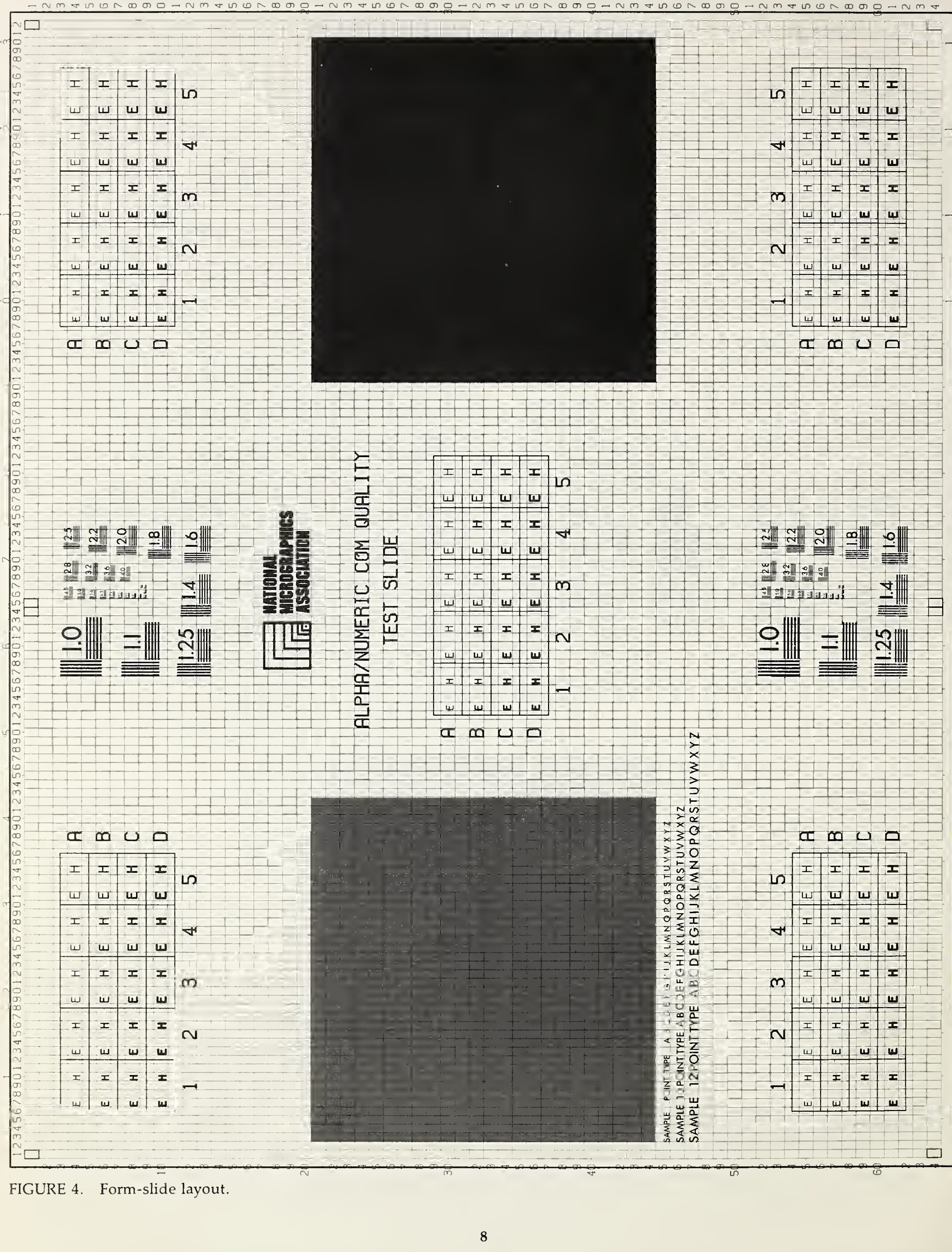

FIGURE 4. Form-slide layout.

image and therefore the quality of the optical system, but it does not yield information concerning character quality from the image generator. The resolution test target should be used in evaluating the losses that occur when making duplicates.

The artwork from which the COM Quality Test Form Slide is made consists of a high-quality image containing the information shown in Figure 3. The artwork from which the form slide is made exceeds the specifications contained in section 14.2. In addition, the test slide contains information that goes beyond the limits recommended for production form slides. This has been done because the test slide is intended to determine the performance limits of the system. The image contains five identical patterns located at the center and at the four corners of the form. It also includes two density squares 4 inches square. The right one, which would be a clear area on the slide, is for use with positive-appearing film. The left one contains a 50-percent halftone screen pattern and is for use with negative-appearing film. Using the halftone pattern, which is unresolvable on film, is necessary to yield a measurable density on film when reversal processing is used. This procedure provides a means for controlling the exposure level. Two resolution targets, made according to ANSI/ISO 3334–1979, are included for use in optimizing or checking the optical focus of the form-slide image.

Each image pattern contains an array of 20 pairs of characters (the letters *E* and *H*). Each pair of characters is identified by a grid coordinate position, rows A through D vertically and columns 1 through 5 horizontally. Each pair of character dimensions, based on a full-size computer page 335 by 270 mm (13.2 by 10.7 inches) with the character height measured from the center line of the upper bar of the character *E* to the center line of the lower bar, changed progressively in the following manner. Horizontally, the left pair of characters (row 1, *E* and *H*) is 2.0 mm high and increases in size by 0.2 mm for each successive pair so that the right pair (column 5) is 2.8 mm high.

Vertically, the characters vary in line width. All the characters in each row have the same line width regardless of character height. The top row (A) has a line width of 0.28 mm; the second row (B), 0.35 mm; the third row (C), 0.48 mm; and the bottom row (D), 0.70 mm.

Two character spaces are provided between characters horizontally and one line between characters vertically to ease aligning image generator characters with the form slide. The location of each form-slide character, based on 132 characters a line by 64 lines a page, is shown in Figure 4. Rows 49 and 50 are reserved for the entire COM character set.

7. LEGIBILITY TEST

The following legibility test is intended for a COM recorder that is not optimally adjusted. If the recorder is producing acceptable output, then the test described in section 7.1 may not be required, except that sample output should be generated and evaluated for use as a reference for future tests. Film processing must be in control when this test is conducted.

7.1 INITIAL TEST AND REFERENCE SAMPLE. A test program is generated to produce the same characters as shown in Figures 3 and 4 on the image generator, but displaced one character position to the right. For instance, an *E* will be located at row 4, column 8; an *H* at row 4, column 11; an *E* at row 4, column 14, etc. In addition, two lines containing all of the alphanumeric and special symbols being used should be displayed along rows 49 and 50. Aligning the form-slide and image generator display can be facilitated by generating a reference character, of the user's choice, in each of the four corners of the page and at positions 64 and 65 of the first and last rows and by aligning these with the character boxes located on the form slide.

If the optical system in the COM unit has not been preset to yield optimum focus, this procedure can be accomplished by using the form slide in the alignment mode and by adjusting the lens for maximum resolution at the image plane. Normally, this adjustment, if needed, should be performed by the manufacturer's customer service engineer.

After proper focus and alignment, several frames of the form slide should be exposed, with the settings recorded, at various form-slide exposure levels. Then the film should be processed and examined with a microfilm viewer. The exposure level should be chosen that gives an image in which the thinnest *EH* pair (grid coordinate A1) appears underexposed and the heaviest *EH* pair (grid coordinate D5) appears overexposed. If this condition exists at more than one exposure level, then the exposure in which the amount of underexposure (grid coordinate A1) and overexposure (grid coordinate D5) appears similar should be chosen.

Using the form-slide illumination setting established in the previous test, make an exposure series, with the settings recorded, of the *EH* pattern using the image generator. After processing the film, examine the images using a full-size blowback microfilm reader (if available). Choose the exposure level that produces acceptable images from the image generator, and compare the acceptable dynamic images to those having the same height and line width in the form slide. Record the image generator exposure setting and the location of the comparable form-slide *EH* pair. Also record the highest resolution target that can be read.

Once the optimum original microimage has been selected and the settings have been recorded, a reference test sample should be produced for use in a duplication test. A duplication test is required because this duplicate is the image presented to the user.

Using the reference test sample, a series of test copies should be made with the duplicator at each significant

exposure setting. Depending on the duplication equipment used, the settings for illumination or exposure and for speed or time should be recorded for cross-reference purposes.

Following the same procedures outlined above, check the duplicate samples, first for best density and next for best resolution. The settings that yield the best test copy should be recorded for future reference and a duplicate reference sample should be produced. The resolution loss in duplicating should not be greater than one resolution pattern.

When a proper exposure level is established, the coordinate positions of the pair of *E*'s and pair of *H*'s (e.g., grid coordinate C4) that appear most nearly the same also should be recorded. The coordinates should be recorded for each of the five target locations, since a different match may occur at each location.

To obtain reproducible results in future tests, the density of the density square of the first-generation, or camera silver, image must be measured. If the processing used produces a positive-appearing image (1P), the density of the image of the clear area (right side) of the slide should be measured. If the processing used produces a negative-appearing image (1N), the density of the image of the screened area (left side) of the slide should be measured. The aperture of the densitometer must be smaller than the density square (2 mm at 48X) to insure valid readings. *When the densitometer aperture size closely approximates the test area size, several readings of the same area should be taken, removing and replacing the microfilm from the stage each time. Inconsistency among these consecutive readings indicates a need for a smaller aperture.* If a densitometer is not available, a fairly good approximation may be made by visually comparing the test sample with the reference sample, comparing narrow lines of relatively low density (row A) for best results. To make this comparison, place the reference and test samples side by side in a reader (it may be necessary to cut the samples), and compare the form images in the upper left corner (grid coordinate A1) of the test targets. Generally, the lower exposure level will appear as thinner lines or lower contrast. Although it is possible to conduct this test using a reader screen, the preferred method of examination is by a microscope.

7.2 ROUTINE TESTING. The output of the COM unit should be monitored on a regular basis using the Alphanumeric COM Quality Test Form Slide. The dynamic output from the image generator should be compared with the form slide as previously described. The exposure level of the forms illuminator should be adjusted, if needed, to provided the same intensity as that of the original reference camera film test. Then sample output is generated and checked for a match between routine and reference test samples. If a densitometer is available, the density square made from the form slide should be within ± 0.05 density of the reference sample. If the proper match is not achieved, the COM recorder should be adjusted to yield the proper match. In general, this adjustment should require only a change in image generator exposure level.

8. MICROFILM DENSITY

This section provides guideline values of image and background density for first-generation imagery and for distribution copies. These values may not be satisfactory in all situations, however. For instance, if there are several film generations between the COM-generated film and the distribution copy or if equipment performance, such as excess flare light in a viewer, is coupled with a positive-appearing image, then different limits on density may be necessary. Generally, values outside the limits given in this section reduce the probability of consistently satisfactory system performance.

8.1 GENERAL DISCUSSION. A major problem associated with specifying COM-generated image density is the difficulty of measurement. The very small size of the image requires using a microdensitometer. Not only is this equipment very expensive and the measurements time consuming to perform, there are no standards to permit conducting valid, reliable measurements.

Because of the general impracticality of measuring COM character density directly, alternative methods are used. One alternative has been to measure the density of the cut mark or blip mark, since this mark is generally large enough to examine in a regular densitometer. However, this procedure can lead to serious errors, since these marks are generated by a light source other than the image generator. This same problem occurs if a forms flash is used to expose a large area of the image. In addition, even if a large area and regular images are recorded with the same light source, the smaller images usually will have a different density value than the larger images because of light scatter in the film emulsion and the effects of film processing.

This section only discusses optical transmission density and is concerned solely with maximum and minimum densities for character images, rather than the entire density range.

The optical transmission density (referred to subsequently in this section as density) of a microfilm image plays a critical role in a COM recorder. Satisfactory system performance is impossible to achieve if the background density for positive-appearing images (1P) is too high, the background density for negative-appearing images (1N) is too low, the density difference between the image and the background is inadequate or the density variation over the image area is too large.

Microfilm image density is a measure of the modu-

lation (attenuation) of light (or other spectral radiation) when the microfilm is illuminated on one side and viewed on the other. The measured value of density is the logarithm, to the base 10, of the ratio of radiant flux incident on the sample to the radiant flux transmitted. The density of a given sample generally is not unique, but it strongly depends on the measurement conditions. Commonly used density measurements include diffuse, projection and printing density.

8.1.1 DIFFUSE DENSITY. Diffuse density occurs when the sample is illuminated with diffuse light from one side and viewed from the other side, such as when viewing a photographic transparency on a light table. *Diffuse density is the type measured by common transmission densitometers.* When the detector in the densitometer has the same spectral response as the so-called human standard, then the measurements are referred to as *visual-diffuse density*. In this case, the energy source is at a stated color temperature, such as 3,000 K for black-and-white photographic materials (see ANSI PH2.19–1976, *Conditions for Diffuse and Double Diffuse Transmission Measurements*).

8.1.2 PROJECTION DENSITY. Projection density occurs when the sample is illuminated by parallel light or by light confined to some prescribed input cone angle and when the image is projected by an objective lens such as that in a microfilm viewer. The density value obtained in this case depends largely on the light-scattering characteristics of the image and on the cone angles involved. Projection density is never less than diffuse density and is often much higher, for instance, when using vesicular film [see ANSI PH2.37, *Conditions for f/4.5 and f/1.6 Projection Transmission Measurements (Projection Density)*].

8.1.3 PRINTING DENSITY. Printing density is a measure of the density of a sample when the response of the detector is the same as that of the duplicate film itself, such as might be encountered in making a duplicate onto diazo or vesicular film. In microfilm duplication an ultraviolet filter frequently is used to make this measurement. Diffuse printing density is most commonly measured.

Silver-film density usually is determined by the visual-diffuse method described in ANSI PH2.19. Visual-diffuse density measurement of diazo films uses the same type of equipment as that used for silver, except that some densitometers may require adding a Corning 4–94 infrared rejection filter. The projection density of vesicular films is determined by equipment that simulates a projector with an *f*/4.5 aperture.

In today's COM systems, first-generation film is a form of silver film and is frequently *positive appearing (1P). Such film images are spectrally neutral.* Further, in most duplicators the film to be copied is illuminated with reasonable well-collimated light. Therefore, using visual-diffuse density to describe first-generation film generally yields satisfactory results, except when halide-reversal film is employed for duplicating onto diazo film. In this case printing density is the proper measurement. However, tonal changes may occur in halide-reversal films during the course of making a measurement, resulting in background density increases.

Depending on the film-processing combination, it may be necessary to use printing density as a measurement when reversal processing is used to obtain a negative-appearing (1N) image. Using printing density is necessary because a stain that is not spectrally neutral may occur on the image, having a higher density for near-ultraviolet radiation than for visible radiation.

For distribution copies, projection density should be specified. However, if the image scatters light only slightly or not at all, such as diazo or fine-grain, silver-gelatin print film, then specifying visual-diffuse density is a satisfactory compromise. If the distribution copy is vesicular film, which is very highly scattering, projection density is essential to obtain meaningful values. In this case the projection density should be measured using an optical system with the same numerical aperture (or *f* number) as the viewer. Since this is generally impractical, an *f*/4.5 optical system has become the standard reference aperture used for these measurements.

8.2 DENSITY OF FIRST-GENERATION FILM (COM CAMERA FILM). The line and background density requirements for first-generation film depend on how the film will be used. If, for example, the film will be used for making duplicates, then diffuse density and printing density are important. The image contrast, or density difference between the background and image, must be sufficient to yield duplicates with usable contrast. The density variation of images from the form and characters should be small enough to provide reasonable exposure latitude during duplication, while the minimum density must be low enough to provide satisfactory throughput speed in the duplicator. If the film is to be used for projection viewing or to make hardcopy, then the projection density characteristics become the governing factor and diffuse density is of minor importance. In duplicating COM-generated images, the duplicating stock used is generally diazo or vesicular film; however, silver print films also are employed. Table 1 summarizes density recommendations.

8.2.1 POSITIVE-APPEARING (1P), COM SILVER-GELATIN FILMS. Positive-appearing, first-generation COM film may be used for direct viewing or for making duplicates onto vesicular film or diazo film depending on the polarity desired. The density values depend on the intended use.

8.2.1.1 POSITIVE-APPEARING (1P) COM FILM USED FOR MAKING DUPLICATES. The background-diffuse density (fog) of the film plays a major role in determining the throughput speed achievable with a particular duplicator. The higher the background density, the lower the throughput speed achievable for a given level of output quality.

TABLE 1. Summary of acceptable density limits.

Film type	*Process*	*Density measurement method*	*Minimum* Dmax	*Maximum* Dmin	*Minimum density difference*
Silver gelatin (1P)	Conventional	Printing or visual diffuse	0.75*	0.15 or 0.10 plus base†	0.60
Silver gelatin (1N)	Full reversal	Printing	1.50 (1.80 preferred)	0.20 plus base†‡	1.30
Thermally processed silver (1P)	Heat	Printing	1.00*	0.40 plus base†	0.60 (0.80 preferred)
Diazo (2N)	Ammonia	Visual diffuse	1.30	0.15 plus base*	—
Vesicular (2N)	Heat	*f*/4.5 projection, visual	1.80	0.15 plus *D**§	—

*Character or line density, measured with a microdensitometer or by comparing the film under a microscope with an image of a known density.

†Base equals the density of the uncoated base.

‡Character or line density, measured with a microdensitometer or by comparing the film under a microscope with an image of a known density; the cut mark is useful for processing control only.

§*D* equals the density of unprocessed film that has been cleared.

For this reason, a minimum background density commensurate with the system should be the goal.

The background printing of diffuse density of silver-gelatin film should be a maximum of 0.10 plus the density of the base material. Most often, a clear-base material with a density of no more than 0.05 is used. If dyes are used in the base, this density may be higher.

Printing density should be measured for thermally processed silver films. The base-plus-fog density should not be greater than 0.40.

The density difference between the character and the background is usually a compromise. A large difference is desired to make duplicating simple, but, with many COM films, the image spreads or blooms severely at high exposure levels. This spread decreases the effective resolution of the system and degrades image quality. The compromise density difference is usually less for 48X images than it is for 24X.

A minimum density difference of 0.6 is essential to obtain reasonable duplicates onto a high-contrast copy film such as vesicular film. For good, consistent quality a density difference of 0.8 or greater is recommended.

Density variation over an individual frame can create problems in obtaining a legible duplicate.

8.2.1.2 POSITIVE-APPEARING (1P) COM FILM FOR DIRECT PROJECTION VIEWING ON READERS ONLY. Positive-appearing COM film that will be used for projection viewing should have the same density levels as film to be used for making duplicates. Base-plus-fog level should be less than 0.15; otherwise, reader screen brightness can be impaired, and at high background densities emulsion graininess can seriously degrade image quality.

8.2.2 NEGATIVE-APPEARING (1N), COM SILVER-GELATIN FILM. Negative-appearing, first-generation COM film is used for direct viewing in readers for prints from reader–printers or for duplicating onto diazo film. The density requirements depend on the end use. With some film-processing combinations, a residual stain may be present on the film, resulting in a printing density considerably higher than the diffuse density. In this case it will be necessary to determine the printing density.

8.2.2.1 NEGATIVE-APPEARING (1N) COM FILM USED FOR MAKING DUPLICATES. High line density can seriously affect duplicator throughput speed. Cut-mark density should not exceed 0.2. Values higher than 0.2 can affect duplicator throughput speed seriously. The background density should not be less than 1.5. A background density greater than 1.8 will yield consistent high-quality duplicates. The minimum background density tolerable depends on film granularity (graininess).

8.2.2.2 NEGATIVE-APPEARING (1N) COM FILM FOR DIRECT PROJECTION VIEWING ONLY. Negative-appearing COM film that will be used for projection viewing only should have the same general density levels as film to be used in making duplicates. The projection density, however, which depends on the film granularity, will be higher than the visual-diffuse density. A background density of 1.5 measured as visual-diffuse density will yield higher densities when measured as projection density, with the values depending on film granularity. While a fine-grain film with a visual-diffuse density of 1.5 may show a projection density of 1.7 (at *f*/4.5), films with a coarser grain may yield values of 1.8 and higher. Halide-reversal films show significantly higher values for projection density than for visual-diffuse density.

9. DENSITY OF DISTRIBUTION COPIES

9.1 NEGATIVE-APPEARING (2N) VESICULAR FILM. The *f*/4.5 projection density of the background should be a minimum of 1.8. One study has shown that optimum exposures using vesicular film occur when the background density is approximately 85 percent of the maximum density of fully exposed film.

9.2 NEGATIVE-APPEARING (2N, 3N, ETC.) DIAZO FILM. The visual-diffuse density of the background should be a minimum of 1.3.

9.3 POSITIVE-APPEARING (2P, 3P, ETC.) FILM. Since positive-appearing distribution copies are rarely used with COM, recommended values are not included in this document.

10. RESOLUTION AND QUALITY INDEX

The resolving power measurement is used to determine the ability of the photographic system to record fine detail. Since the resolving power measurement is made using a high-quality, high-contrast form slide and not the image generator, it is not a measure of the character resolution. Measuring resolving power will

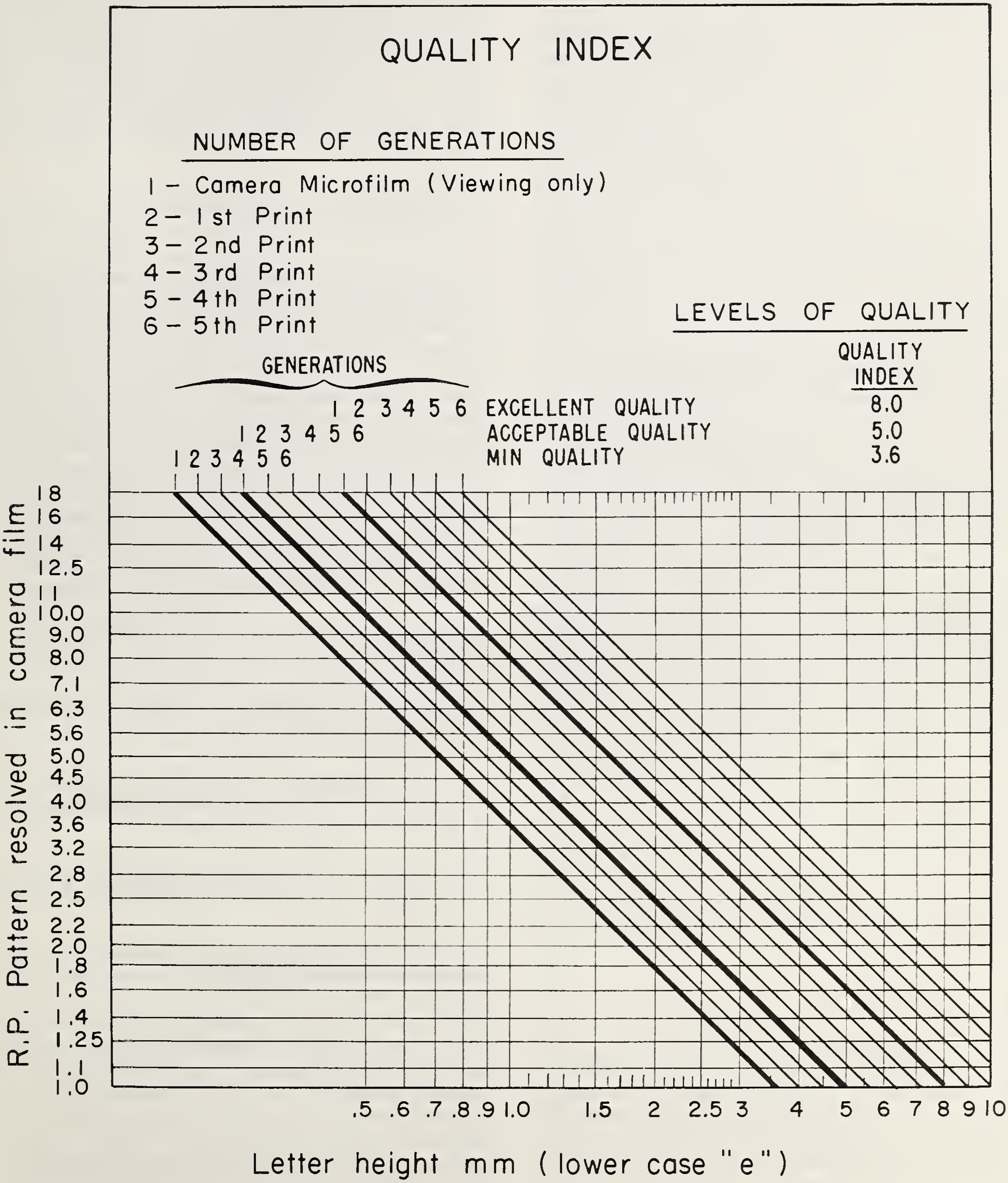

FIGURE 5. Quality-index graph.

help determine if the system is capable of recording fine detail.

10.1 REQUIREMENTS. The resolving power requirements for COM recording depend on the information being recorded and on the reduction used. If the data consists of lowercase or complex characters, then the resolving power requirements are higher than if all uppercase characters were used.

If the lowercase *e* is used, then the full-size equivalent of this character may be used along with the nomograph given in Figure 5 to determine the resolution pattern that should be resolved for acceptable quality. For example, frequently the full-size equivalent of the lowercase character *e* in alphanumeric COM recording is 2.0 mm high. If the first-generation film will be used for duplicating to yield second-generation film, examining the nomograph given in Figure 5 reveals that, for acceptable quality, the resolution pattern 2.8 should be resolved in the camera film. For minimum quality under the same circumstances, pattern 2.0 should be resolved.

If only uppercase characters are used, the height of the uppercase *E* may be employed in using the nomograph. The typical full-size equivalent height of this character is 2.5 mm. However, this height may vary over a considerable range, depending on the particular recorder setup and on user preference. Assuming the 2.5-mm height, then pattern 2.2 should be resolved for acceptable quality. The highest resolving power obtained in the camera film exposure series using the test slide is the maximum obtainable from the system. The character size in the particular unit can be determined through the match of the *EH* pattern from the form slide and image generator. The equivalent full-size height of the uppercase *E* in the form-slide image varies from 2.0 to 2.8 mm as stated in section 6. Although these measurements represent the distance from the center of the top horizontal line to the center of the bottom horizontal line of the character *E* rather than the overall height, these values can be used for approximation in determining resolution requirements. Since this entire measurement represents an evaluation of the photographic system rather than the image generator and since the quality of the image from the image generator is less than that of the form slide, erring on the side of higher resolution requirements can prove beneficial.

11. REPRODUCIBILITY

All characters must be recorded so that they can be read easily by users, which means that the quality of the first-generation camera film must be sufficiently high to allow for the normal image degradation that results when making subsequent-generation copies. *The maximum acceptable loss in resolution is about 12 percent for each subsequent generation.* The duplication step should result in the loss of not more than one resolution pattern between camera film and duplicate.

12. PRINTABILITY TEST

To insure that users can obtain legible hardcopy prints, a printability test should be conducted on the same type of reader–printer available to the end users or customers. Two frames should be selected at random on the distribution microform sample. Using any enlargement ratio in the range of 70 to 100 percent of the effective reduction, paper prints should be made. The prints should be examined for legibility. If the prints are not legible, the cause should be ascertained and corrected.

13. STANDARDS FOR STORING MICROFILM

The care used in storing microfilm, especially the original, definitely can affect the capability to reproduce or use the film at a future time. COM film used as permanent records must be stored in a location that meets the environmental conditions of the archival storage requirements specified in ANSI PH1.43. In any case, it is recommended that microfilm be stored in proper storage containers and in environmentally controlled areas where the temperature does not exceed 21 C (70 F) and the relative humidity does not exceed 40 percent. *Also, if the humidity is too low, film degradation may occur. ANSI PH1.43 should be consulted for specifics.* Do not interfile dissimilar films (i.e., silver, dry silver, vesicular or diazo) in the same storage containers.

14. GENERAL GUIDELINES FOR PREPARING FORM SLIDES

These guidelines are intended to assist form-slide users and vendors in insuring optimum quality.

NOTE: These are general guidelines and not simply a description of the form slide used in comparing image quality as described in this standard.

14.1 ORIGINAL ARTWORK. All dimensions refer to the full-size master unless otherwise specified by the COM manufacturer.

14.1.1 DIMENSIONAL STABILITY. The original artwork should be dimensionally stable. A polyester-base material is preferred.

14.1.2 LINE DENSITY. The form lines should have sufficient density to prevent their filling in when reduced to fit on the form slide.

14.1.3 CHARACTER SPACING. The clear space between adjacent characters should be a minimum of 0.2 mm (0.008 inch).

14.1.4 LINE WIDTH. The form lines should have a minimum width of 0.2 mm (0.008 inch). The width of a

line to be used to separate characters should not exceed 0.3 mm (0.012 inch). Individual form lines should have a constant width to within ± 5 percent.

14.1.5 TYPE SIZE AND STYLE. The smallest character on the form should be not less than 2.0 mm (0.08 inch) high. A medium or bold sans serif font of at least 8 points is preferred for maximum legibility.

14.1.6 HALFTONE SCREENS. If logos or other identifying symbols will be used on the form slide, halftone screens of not more than 65 lines and 35-percent transmission are recommended. Halftone screens should not be used in any area where data is printed.

14.1.7 COLOR. The artwork should be black on a white background or black on a transparent background.

14.2 FORM SLIDE. The information in this section is intended primarily for form-slide manufacturers in preparing specifications by users.

14.2.1 POLARITY. The form slide should be negative appearing; that is, clear lines on a dark background.

14.2.2 MATERIAL. Silver-halide emulsion coated on a stable polyester or glass plate is preferred. The material should satisfy the requirements of the COM manufacturer.

14.2.3 RESOLUTION. The camera used for generating the form slide shall be capable of resolving the 9.0 target of the NBS 1010 Microcopy Resolution Test Chart at the image plane of the form slide, regardless of the reduction used to reduce the full-size artwork to the form-slide dimensions.

14.2.4 LINE DENSITY. The line density of clear areas of the form slide should not be greater than 0.1.

14.2.5 BACKGROUND DENSITY. The background density should be 2.0 or greater.

14.2.6 DEFECTS. There should be no defects or pinholes greater than 0.0013 mm (0.0005 inch) in any dimension.

14.2.7 LINE-WIDTH UNIFORMITY. Each line on the form slide should be uniform to its specified width to within ± 5 percent.

15. REVISION OF STANDARDS REFERRED TO IN THIS DOCUMENT

When the following standards referred to in this document are superseded by a revision, the revision shall apply.

American National Standard *Conditions for Diffuse and Doubly Diffuse Transmission Measurements (Transmission Density)*, PH2.19–1976. New York: American National Standards Institute, 1976.*

American National Standard *Conditions for f/4.5 and f/1.6 Projection Transmission Measurements (Projection Density)*, PH2.37. New York: American National Standards Institute, forthcoming.*

American National Standard *Methylene Blue Method for Measuring Thiosulfate and Silver Densitometric Method for Measuring Residual Chemicals in Films, Plates, and Papers*, PH4.8–1978. New York: American National Standards Institute, 1978.

American National Standard *Microcopying: ISO Test Chart 2: Description and Use in Photographic Documentary Reproduction*, ANSI/ISO 3334–1979. New York: American National Standards Institute, 1978.

American National Standard *Specifications for Photographic Film for Archival Records, Silver-Gelatin Type, on Cellulose Ester Base*, PH1.28–1976. New York: American National Standards Institute, 1976.

American National Standard *Specifications for Photographic Film for Archival Records, Silver-Gelatin Type on Polyester Base*, PH1.41–1976. New York: American National Standards Institute, 1976.

American National Standard *Specifications for Safety Photographic Film*, PH1.25–1976. New York: American National Standards Institute, 1976.

American National Standard *Specifications for Stability of Ammonia-Processed Diazo Photographic Film*, PH1.60–1979. New York: American National Standards Institute, 1979.

American National Standard for *Storage of Processed Safety Photographic Film*, PH1.43–1979. New York: American National Standards Institute, 1979.

National Micrographics Association *Glossary of Micrographics*, TR2–1980. Silver Spring, MD: National Micrographics Association, 1980.

National Micrographics Association *Practice for Operational Procedures/Inspection and Quality Control of First-Generation Silver-Gelatin Microfilm of Documents*, NMA MS23–1979. Silver Spring, MD: National Micrographics Association, 1980.

NOTE: American National Standards and National Micrographics Association standards are available from Publications Sales, National Micrographics Association, 8719 Colesville Road, Silver Spring, MD 20910 (301/587–8202). ANSI standards marked with an asterisk (*) can be ordered only from ANSI directly. Write: ANSI, 1430 Broadway, New York, NY 10018.